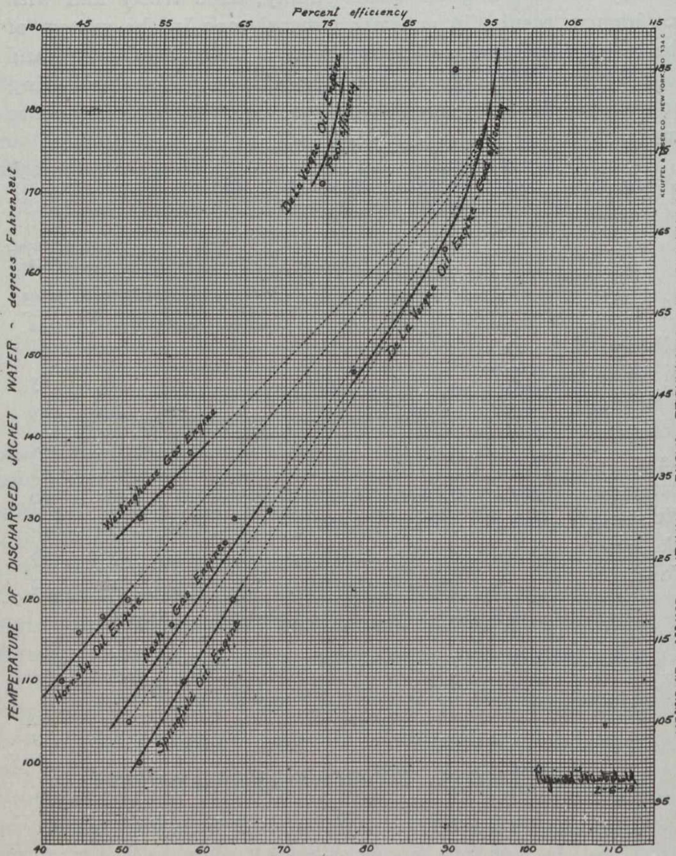
factory operation; and 2nd, the temperature at which the water should be discharged from the jackets. The first consideration governs the amount of jacket water that should be used, as the available temperature range of jacket water supply is inconsequential, when the intense heat of the gases at the moment of ignition is taken into consideration—a point of importance when the jacket water is cooled on discharge from the jackets and used over again, a practice that is nearly universal. The second consideration is but a logical deduction from the first, but it is, nevertheless, upon this point that the economic consumption of fuel or thermal efficiency of the engine largely depends.

Engines operating under all degrees of efficiency must be considered before any conservative and reliable rule can be advanced to govern the supply and temperature of the jacket water that will assure the converting of the greatest proportion of the heat units supplied by the fuel into useful energy. Hence, the data given in Table I does not do justice to the possibilities of the various types of engines mentioned, nor does it properly indicate their relative efficiencies, but is merely a record of the jacket water temperatures of engines operating under various degrees of efficiency.

**Table I.**

| Type of Engine | Fuel and Heating Value | Consumption of Fuel per Horsepower | Jacket Water Increase Range | Temperatures Discharged Water |
|---|---|---|---|---|
| Oil Engine "A" | Kerosene | 17,000 B.T.U. | 52.0 F. | 110 F. |
| | 20,000 B.T.U. | 16,250 | 53.0 | 116 |
| | per pound | 15,250 | 53.5 | 118 |
| | | 14,300 | 54 0 | 120 |
| Oil Engine "B" | Gasoline | 13,900 B.T.U. | 55.0 F. | 100 F. |
| | 18,000 B.T.U. | 12,650 | 57.5 | 110 |
| | per pound | 11,400 | 62.5 | 120 |
| Oil Engine "C" | Fuel Oil | 9,250 B.T.U. | 73.5 F. | 148 F. |
| | 19,000 B.T.U. | 8,100 | 88.5 | 163 |
| | per pound | 7,750 | 103.0 | 176 |
| | | 8,000 | 111.0 | 185 |
| | | 9,750 | 97.0 | 171 |
| | | 9,600 | 110.0 | 184 |
| Gas Engine "A" | City Gas | 14,250 B.T.U. | 63.5 F. | 110 F. |
| | 560 B.T.U. | 13,000 | 67.5 | 117 |
| | per cubic foot | 11,600 | 73.0 | 127 |
| | | 11,400 | 73.0 | 130 |
| | | 10,650 | 78.0 | 131 |
| Gas Engine "B" | City Gas | 13,850 B.T.U. | 82.0 F. | 130 F. |
| | 560 B.T.U. | 12,950 | 84.0 | 134 |
| | per cubic foot | 12,450 | 87.0 | 138 |

The effects of temperature range of jacket water on the fuel consumption are graphically illustrated by the curves of Fig. I, a chart which clearly indicates two important facts. One, that the relation existing between the range of temperature of jacket water and consumption of fuel, for engines operating on fuels of about the same heating value, follows closely the relationship illustrated by the smooth curve designated "Relation Curve" and that about the same relation exists for engines operating on fuels of any specific heating value. Two, that the temperature of the water supplied to the jackets, within usual limits, has little effect upon the efficiency of the engine as far as fuel consumption is concerned. Considering only the engines operating on fuels of about the same richness or heating value, it is seen that the fuel consumption decreases rapidly with any increase in the temperature range of the jacket water for relatively small values of heat absorption by the jackets and that the rate of fuel consumption continues to decrease with increasing temperature range of jacket water, with gradual retardation, until a temperature range of about 105 degrees Fahrenheit is reached, after which the fuel consumption of the engine remains about constant. During this period of minimum fuel consumption, little or no gain in efficiency is obtained by increasing the temperature of the range of the jacket water, and if increased to such a point that the discharge temperature is too high, a point that will be referred to again, serious generation of steam in the jacket will occur, reducing the efficiency of the jacket and upsetting the rule that increased temperature range of jacket water is conducive to reduced fuel requirements. With unusually cold water supply it is possible, of course, to retain the water in the jackets until a considerable range of temperature takes place, but as previously stated the possible temperature range of the jacket water supply is limited and the possible gain in fuel consumption due to increased temperature range of jacket water is hardly sufficient to warrant running the risk of an interference with the water supply that may counteract the small gain in economy of fuel consumption through increased temperature range of jacket water by a too great increase in the




COMPARISON WITH ENGINE OF 35 % THERMAL EFFICIENCY

CHART II.

temperature range of the jacket water to from 100 to 130 degrees Fahrenheit, depending upon the temperature of the water supplied to the jackets, in ordinary installations of internal combustion engines. Engines operating on fuels of lesser heating value, require a greater range of jacket water temperatures to give the same fuel economy as those operating on fuels running about 18,000 or 20,000 B.T.U. per pound but, as in all cases, the temperature range of the jacket water is limited by the temperature at which it is discharged from the jackets, and this is governed by the generation of steam in the jackets.

About the best thermal efficiency for an internal combustion engine that has yet been attained is 35 per cent., or the delivery of one brake horsepower per 7,250 B.T.U. supplied, and for sake of convenient comparison, such efficiency will be considered as 100 per cent. A comparison of the thermal efficiencies of various engines, as represented by the data of Table I, with that of an engine delivering a horse-